

## **AVIATION MAINTENANCE DATA IN THE UNITED KINGDOM**

David J Hall, Deputy Regional Manager  
UK Civil Aviation Authority

### **Background**

Continued airworthiness is a core activity in the Safety Regulation Group (SRG) of the UK Civil Aviation Authority (CAA). Over the last twelve months we have focused our attention on this aspect to identify potential areas where SRG standards could be enhanced to provide more effective maintenance instructions and produce a significant safety benefit. This is in line with CAA's policy to actively consider what lessons can be learned from in-service experience and to seek future safety improvements. The purpose of this paper is therefore to describe the current activity being performed by the UK CAA in this regard. In the context of this paper reference to the term 'maintenance data', is synonymous with the term 'Information for Continued Airworthiness' (ICA).

In February 2001 the CAA's Continued Airworthiness Co-ordination Group recommended that a review be conducted of samples of maintenance instructions with the aim of identifying where requirements and guidance material, which drives the medium and content of maintenance instructions, can be improved. Where these are identified they are to be offered to the Joint Aviation Authorities (JAA) in the form of Notice of Proposed Amendments (NPA).

### **Introduction**

The problem of inaccurate, incomplete or ambiguous, maintenance data is one well known within the maintenance community. Almost everyone who works on aircraft or their components will probably possess a 'Black Book'. This is a sad indictment of the state of our maintenance data when we have to keep our own record of those correct dimensions or that impossible to find 'O' seal part number. The problem posed to the CAA was to identify the areas of maintenance documentation and data requiring attention. Unfortunately, maintenance personnel rarely admit to possessing 'Black Books', for fear of action from their own organisation or the Regulator. The authors of maintenance data are also deprived of the knowledge contained in Black Books and are therefore ignorant of the need for changes.

Currently the CAA's only method of determining what deficiencies there are in maintenance data is to review reportable events and seek experiences from Surveyors in the Aircraft Maintenance Standards Department and the Design and Production Standards Division.

In performing this review the following data sources were identified as producing the maximum information on any inadequate Information for Continued Airworthiness.

- Mandatory Occurrence Reports
- Engine significant defects database
- Design & Production Standards Division Human Factors listings
- Service Bulletins and Airworthiness Directives
- B777 testing for Early ETOPS
- Air Accident Investigation Branch reports and recommendations

### **Mandatory Occurrence Report Database**

The CAA receives a very large number of Mandatory Occurrence Reports (MOR) each year that have indicated a hazard to the aircraft. For instance, in year 2000 over 7500 reports covering all causes were submitted to the CAA. All occurrences are categorised as to their risk with Category 'A' being the highest risk and Category 'D' being the least. An interrogation of the CAA MOR database, searching for occurrences over the last five years where poor maintenance data was a contributing or causal factor yielded just 51 occurrences. No Category 'A' occurrences were found but 1 Cat 'B', 14 Category 'C' and 36 Category 'D' were identified. Of these, 6 occurrences were the direct result of incorrect maintenance data and 29 were the result of incomplete or ambiguous maintenance data. The result was a little surprising as all the anecdotal evidence from CAA Surveyors and maintenance personnel in industry was suggesting that occurrences would be more widespread. It was determined that this apparent contradiction was largely due to the data input constraints inherent in the database system and shortcomings in its capabilities for performing searches of this kind. For the future, the UK scheme for industry to share the data from their Boeing Maintenance Error Decision Aid (MEDA) processes should provide this sort of non-technical data that is now being recognised as so important.

### **Engine Significant Defects Database**

Since April 1968 the SRG Propulsion Department has maintained a database containing details of engine events that are considered significant. The Engine Significant Defects Database currently has 760 events recorded. A search of these for maintenance related issues revealed 12 events that resulted in a change to the Type Certificate holder's maintenance instructions because they were inadequate. A further 8 events were due to maintenance not being performed in accordance with the manufacturer's instructions. However, it is not clear if these were due to ambiguity in the instructions or due to violations by the maintenance personnel.

### **Design & Production Standards Division Human Factors Listings**

The SRG Design & Production Standards Division (D&PSD) has for some time been categorising Mandatory Occurrence Reports with a human factor content and identifying the human factors issues by type and cause. This listing currently has 78 entries of which 13 showed inadequate maintenance instructions as a contributory or causal factor in the event. Of the 13 occurrences, more than half were attributed to incorrectly performed inspections or checks as a consequence of inadequate or ambiguous maintenance data.

### **Service Bulletins and Airworthiness Directives**

Poorly written Airworthiness Directives and their associated Service Bulletins are something that again, most of the maintenance community have experienced. From a continuous airworthiness perspective these are important as they frequently address known hazards and the effect of failing to meet the modification or inspection objective will almost certainly affect safety. Whilst no database is available to track and identify these, various Departments in the CAA performed a review of those known Airworthiness Directives and Service Bulletins which failed to control the risk. A surprising number were identified including such things as, tasks unable to be performed as written, critical steps omitted, environmental conditions not stated and poor inspection standards. These indicate to the CAA that the system for producing such data requires improvement.

### **Boeing 777 Testing for Early - ETOPS**

To allow the B777 aircraft ETOPS clearance at entry into service, the FAA and JAA stipulated within the certification basis, that Boeing undertake an aircraft 1000 cycle validation test programme. It was to be conducted under operating conditions as near to in-service as possible. This included using airline operators' own maintenance personnel as well as Boeing technicians, the Boeing specified tooling, manuals, wiring diagrams etc. Tasks undertaken and validated included Maintenance Review Board (MRB) scheduled line maintenance tasks, MRB 1C-check tasks, planned non-routine tasks requested by the FAA, maintenance significant tasks and tasks related to new technology on the B777. In total 3129 tasks were validated (some more than once) out of a possible 6282 maintenance procedures. Approximately 10% (324) of the tasks validated required major changes to the maintenance data before the FAA allowed the aircraft to be released into service. In addition 546 Temporary Revisions to the maintenance data were generated for incorporation after release into service and 238 Maintenance Tips to help clarify maintenance procedures and practices. In summary, approximately 10% of the maintenance data was considered to be unacceptable, and a further 20% could be improved, but was considered acceptable for a short period of time.

When considering the foregoing, it must also be borne in mind that the B777 development programme used the most up-to-date processes to ensure that the maintenance data would be as accurate as possible prior to starting the 1000 cycle validation testing.

When all the data changes had been made and the aircraft entered into service, the B777 was widely acclaimed as the most 'service ready' new aircraft type ever operated by the customers. In the UK we have had a fleet of B777 aircraft operating since 1995 and to date we have only had 2 Mandatory Occurrence Reports that have identified poor maintenance data as a causal or contributing factor. The same Operator has a fleet of B747 that has generated 6 Mandatory Occurrence Reports identifying poor maintenance data in the last 2 years.

### **Air Accidents Investigation Branch Recommendations**

The CAA performed a review of the accident reports from the UK Air Accidents Investigation Branch (AAIB) over the last twenty-five years. The search was to identify where errors and omissions in maintenance data contributed to, or caused the event. It identified 102 events that were maintenance related. 74 of these investigations revealed shortcomings in the maintenance data resulting in 100 AAIB recommendations for specific amendment to the data. 12 out of the 74 events were fatal accidents resulting in 143 fatalities and 92 serious injuries.

The review also looked to see how often the aircraft Maintenance Programme was deficient, as opposed to just the maintenance data used by maintenance personnel. This indicated that data errors, such as incomplete, ambiguous, or inaccurate information were far more numerous than deficient aircraft Maintenance Programmes. Given the effort, requirements for reviewing by aircraft operators and direct CAA involvement in approving Maintenance Programmes this perhaps is not so surprising.

### **Conclusions**

Whilst it has been difficult to quantify the true extent of maintenance data errors or inadequacies, anecdotal evidence indicates that these are relatively common occurrences. The B777 experience in particular supports the view that maintenance manuals on initial release are inadequate, even when the latest state-of-the-art tools and procedures are in place. If the maintenance data is not verified on the aircraft, or by other suitable means during the type certification process, failures or inadequacies in the Information for Continued Airworthiness will only become apparent once the aircraft is in service. What had not been quantified previously was any relationship between these inadequacies and the risk to safe operations. Whilst it is accepted that many of the findings are of a minor nature, the data extracted from AAIB recommendations provides quantified evidence that errors in maintenance data are a significant issue which has on average resulted in 4 AAIB recommendations per year to UK registered aircraft alone. The CAA considers that there is sufficiently firm evidence to support initiating a study of various options for mandating verification and validation of at least a proportion of the Information for Continued Airworthiness, and the level of Airworthiness Authority involvement in such work.

### **Future CAA Activities**

As a result of the CAA review of maintenance data described in this paper, a number of recommendations were made and accepted by CAA senior management. These will form the basis for Phase II of this work to be concluded by April 2002.

The recommendations forming the basis for Phase II of the CAA project are:

1. Where a Service Bulletin is issued to address a hazard severe enough to warrant mandatory Airworthiness Directive action, the Service Bulletin should be verified and validated by the manufacturer and approved by the CAA.

2. A condition of a Design Organisation Approval should include the requirement to keep any documentation to support Continued Airworthiness up to date.
3. Determine the potential benefits of enhancing the process for the approval of equipment by specifically including the investigation of the provision of Information for Continued Airworthiness.
4. Perform a cost/safety benefit study of the various options for mandating manufacturer verification and validation of the Information for Continued Airworthiness, or part thereof, and the appropriate level of CAA oversight. This would include the scope of Maintenance Review Board activities.
5. Ensure the intent of NPA 145-12 is met in full by approved maintenance organisations.

Note: the proposed amendment to JAR 145.45 (c) states:

*'The JAR-145 approved maintenance organisation must establish procedures that ensure that any inaccurate, incomplete or ambiguous procedures, practices, information or maintenance instruction contained in the maintenance data used by maintenance personnel is recorded and notified to the applicable type certificate holder responsible for the data.'*

Depending on the outcome of this work a third phase would seek to implement the changes to enhance the quality of the Information for Continued Airworthiness.